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(54) **MOUNTING ARRANGEMENT FOR AN ELECTRICAL HARNESS**

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H02G 3/04 (2006.01)

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See application file for complete search history.

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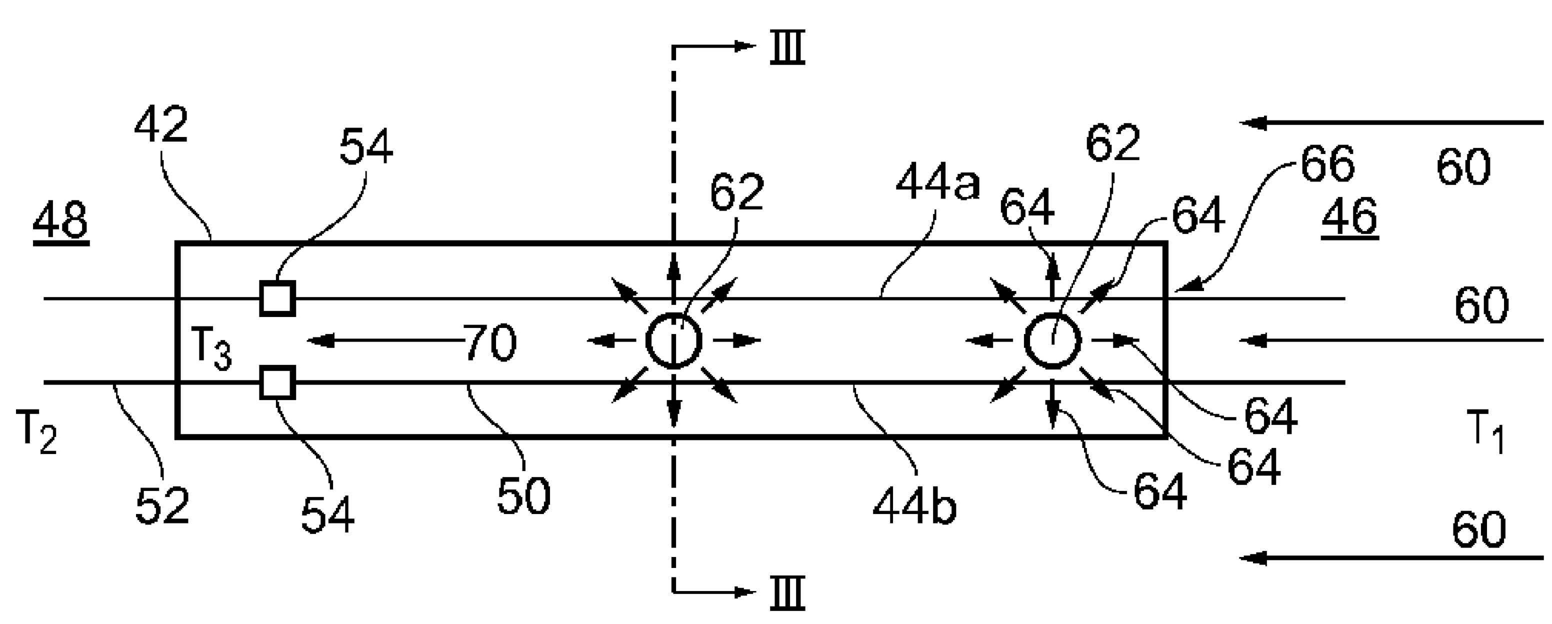
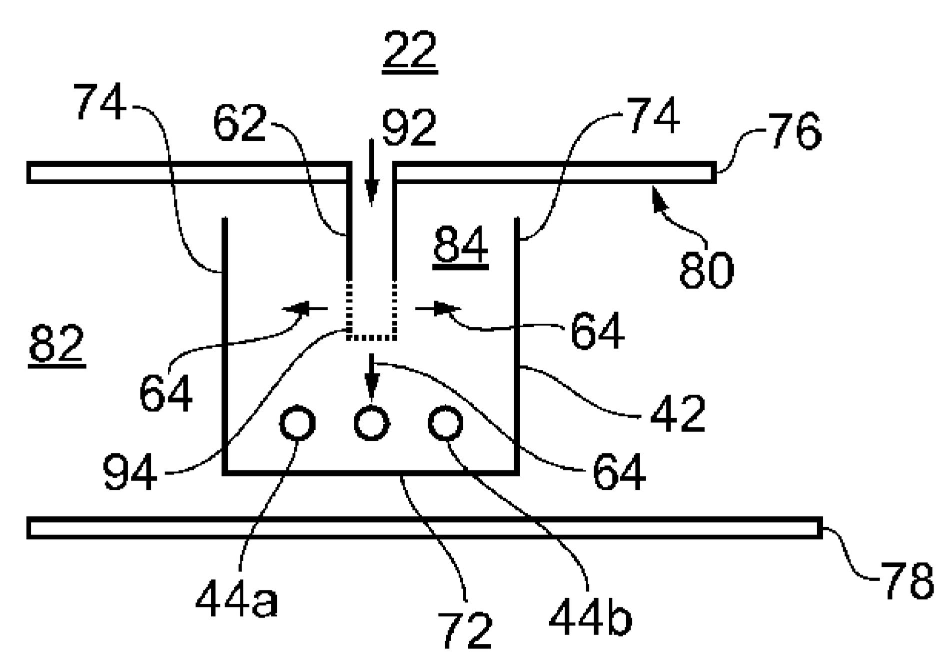
(57) **ABSTRACT**

A mounting arrangement for an electrical harness comprises an elongate tray, the tray having a base and raised sides to define a channel. The electrical harness is mounted within the channel and cooling air is directed into the channel to cool the electrical harness.

14 Claims, 2 Drawing Sheets





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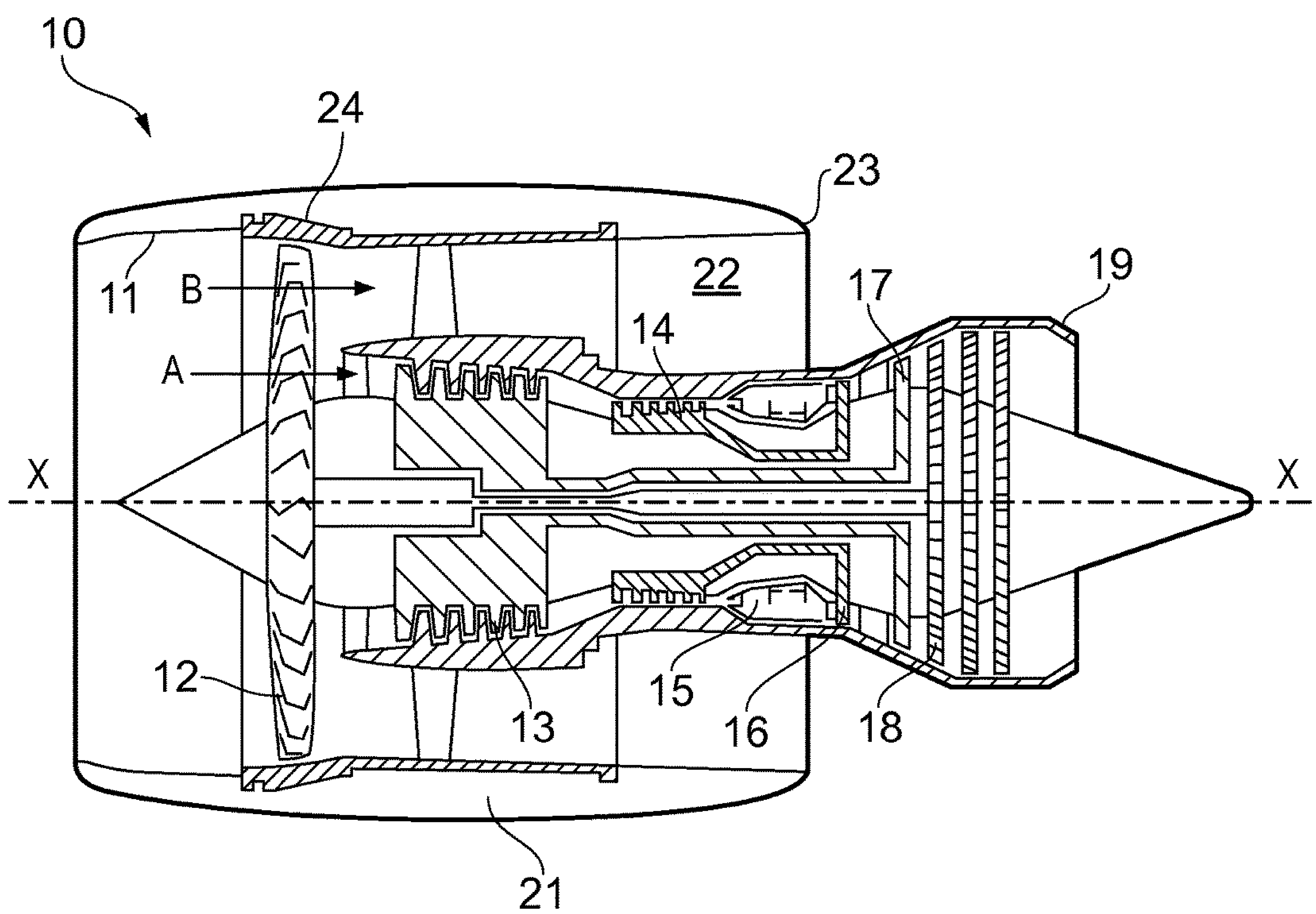
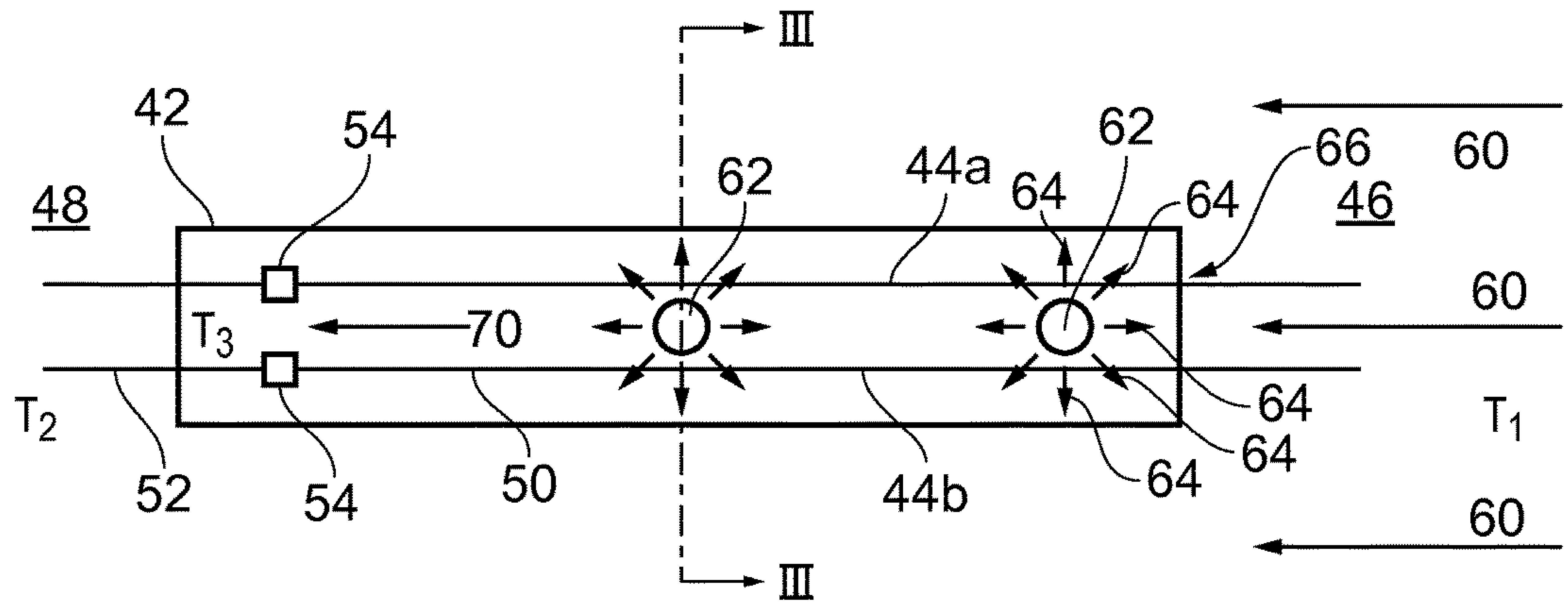
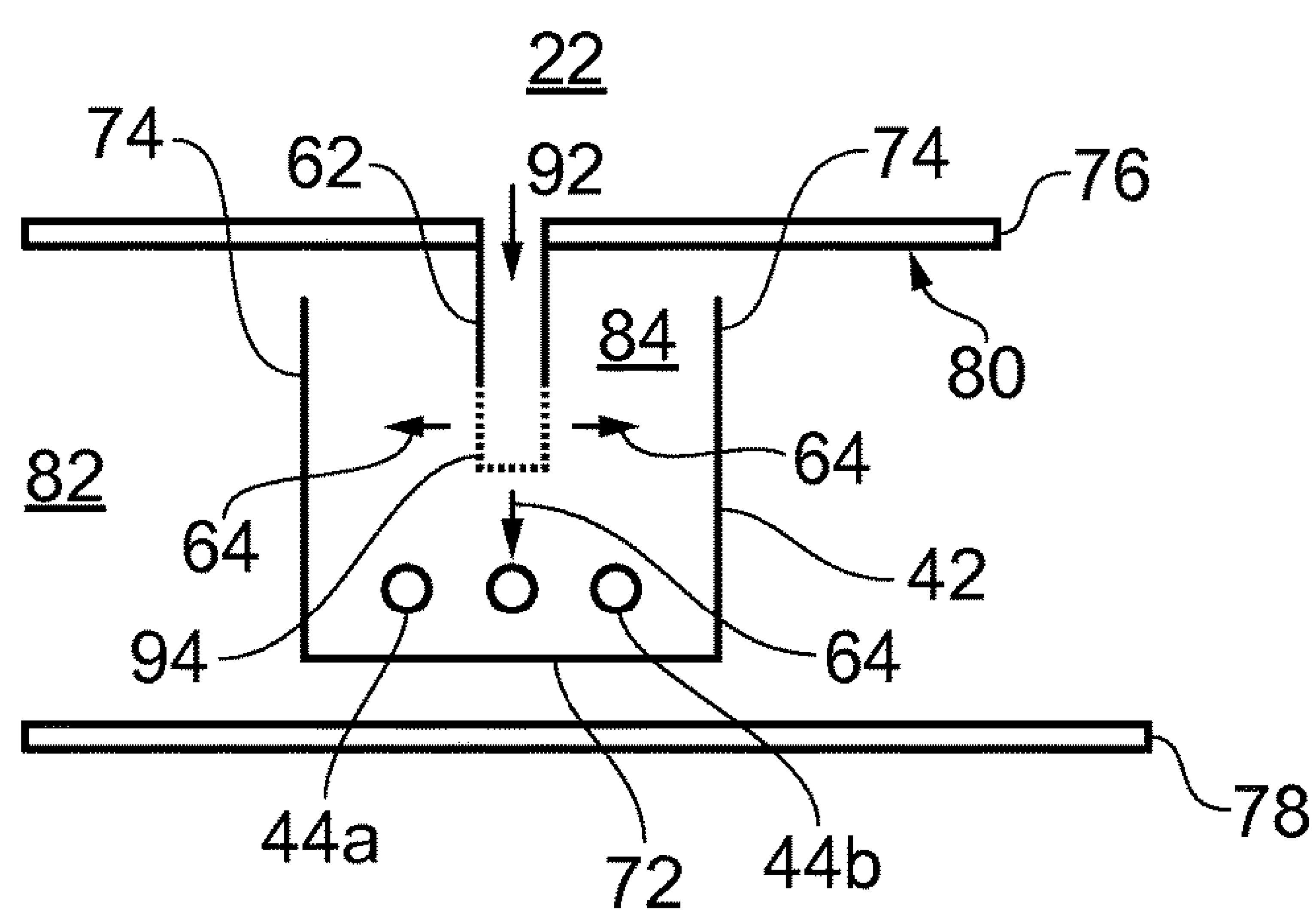


FIG. 1



III
III
42
54
48
62
44a
62
64
64
66
60
46
60
T3
70
64
64
T1
T2
52
54
50
44b
64
60

FIG. 2



22
74
62
92
74
76
84
80
82
64
64
42
94
64
44a
72
44b
78

FIG. 3

MOUNTING ARRANGEMENT FOR AN ELECTRICAL HARNESS

This invention relates to mounting and cooling arrangements for electrical harnesses, in particular (although not exclusively) for use in gas turbine engines.

With reference to FIG. **1**, a ducted fan gas turbine engine is generally indicated at **10** and has a principal and rotational axis X-X. The engine comprises, in axial flow series, an air intake **11**, a propulsive fan **12**, an intermediate pressure compressor **13**, a high-pressure compressor **14**, combustion equipment **15**, a high-pressure turbine **16**, an intermediate pressure turbine **17**, a low-pressure turbine **18** and a core engine exhaust nozzle **19**. A nacelle **21** generally surrounds the engine **10** and together with a fan casing **24** defines the intake **11**, a bypass duct **22** and a bypass exhaust nozzle **23**.

The intermediate pressure compressor **13**, high-pressure compressor **14**, combustion equipment **15**, high-pressure turbine **16**, intermediate pressure turbine **17**, low-pressure turbine **18** and core engine exhaust nozzle **19** together define the engine core. A core casing surrounds the engine core and defines the inner annular surface of the bypass duct **22**.

Pipes and cables are routed around and along the outside of the engine core and the fan casing. It is known to secure the pipes and cable directly to the casings of the engine by a succession of discrete brackets. It is also known to mount the pipes and cables to a shallow metal harness tray, secured to and extending circumferentially around a fan casing, to provide protection against distortion (for example, if fitters use them as handholds). Such trays are typically formed from pressed metal sheet, and (for stiffness) have upturned sides typically about 10-15 mm in height.

During operation, air entering the intake **11** is accelerated by the fan **12** to produce two air flows: a first or "core" air flow A into the intermediate pressure compressor **13** and a second or "bypass" air flow B which passes through the bypass duct **22** to provide propulsive thrust. The intermediate pressure compressor **13** compresses the air flow A directed into it before delivering that air to the high pressure compressor **14** where further compression takes place.

The compressed air exhausted from the high-pressure compressor **14** is directed into the combustion equipment **15** where it is mixed with fuel and the mixture combusted. The resultant hot combustion products then expand through and thereby drive the high, intermediate and low-pressure turbines **16**, **17**, **18** before being exhausted through the nozzle **19** to provide additional propulsive thrust. The high, intermediate and low-pressure turbines respectively drive the high and intermediate pressure compressors **14**, **13** and the fan **12** by suitable interconnecting shafts.

The fire zone commonly referred to as "Zone 3" is formed around the core of the engine and includes the combustion system and turbines. Ventilation air is taken from the bypass duct and injected near to the front or upstream end of the zone; it flows towards the back or downstream end of the engine where it is vented back into the bypass duct. This flow is driven by the difference between the total and static pressures in the bypass duct; because this difference is not very large, the flow velocities are relatively small. Initially, this ventilation air is relatively cool, but of course its temperature rises as it passes through the zone and takes in heat from the surroundings.

Electrical harnesses passing through Zone 3 from the front to the rear are therefore exposed to a steadily increasing temperature; towards the rear this temperature will exceed the capability of the standard PTFE-insulated electrical harnesses, which would degrade and fail if exposed to

such temperatures. Therefore, it is common to provide an electrical disconnect at a suitable position within Zone 3, at which the PTFE-insulated harnesses are terminated and the signals are carried onward by mineral-insulated (MI) cables. MI cables have a higher temperature capability than PTFE-insulated cables, and can withstand the increasing temperatures towards the rear of Zone 3.

However, MI cables are mechanically delicate and so their use in gas turbine engines increases the risk of failures in service. It is desirable to minimise the use of MI cable in the engine, in order to maximise reliability; but if PTFE-insulated cable is used in regions approaching its temperature limit, this also increase the risk of failures. It would be desirable to provide a means whereby PTFE-insulated cable could be used throughout more of Zone 3, while keeping its temperature sufficiently low to ensure its reliability, and without requiring excessive amounts of external cooling.

Accordingly, the invention provides a mounting arrangement for an electrical harness, and a gas turbine engine including such an arrangement, as set out in the claims.

Embodiments of the invention will now be described in more detail, with reference to the attached drawings, in which

FIG. **1** shows a schematic cross-sectional view of a gas turbine engine of known type, which has already been described;

FIG. **2** is a schematic plan view of a mounting arrangement according to the invention; and

FIG. **3** is a cross-sectional view on the line III-III of FIG. **2**.

FIG. **2** shows a mounting arrangement for an electrical harness according to the invention. A tray **42** is mounted to a casing (not shown) of a gas turbine engine by suitable fasteners. If FIG. **2** were to show the whole of the gas turbine engine, the air intake (**11** in FIG. **1**) would be towards the right and the nozzles (**19** and **23** in FIG. **1**) towards the left; the normal flow of air through the engine is therefore from the right to the left of FIG. **2**. The tray **42** is located in Zone 3, and extends in an axial direction through the zone. The tray **42** extends from a first, front or upstream, region **46** in which the temperature is T_1, to a second, rear or downstream, region **48** in which the temperature is T_2. As explained previously, T_2 is higher than T_1. The temperature within Zone 3 increases progressively between region **46** and region **48**.

Two cable harnesses **44***a*, **44***b* are mounted to the tray **42**. Other cable harnesses and pipes may also be mounted to the tray **42**, but are not shown in this drawing. The portion **50** of the harness **44***b* extending from the cooler region **46** is PTFE-insulated cable. The portion **52** of the harness **44***b* extending beyond the tray and into the hotter region **48** is MI cable. The two portions are joined at a disconnect **54**, whose position is chosen to protect the PTFE-insulated cable from excessive temperature. As described previously, a ventilation air flow **60** flows from the front or upstream end of the zone towards the back or downstream end, generally parallel with the alignment of the tray **42**. An opening **66** in the upstream end of the tray allows a fraction of the ventilation air flow **60** to flow into the tray **42**.

A source of cooling air delivers cooling air through two cooling air ducts **62** into the tray **42**. The cooling air ducts **62** have holes or slots towards their ends so that the cooling air flow **64** is distributed in a number of directions into the tray. This ensures that the cooling air flow **64** mixes as quickly as possible into the air flow through the tray **42**, effectively flooding it with cooling air. Although the cooling air ducts distribute the cooling air flow **64** in all directions, the effect of the ventilation air flow **60** passing through the tray is to encourage a general flow of air **70** along the tray **42**, from its upstream end to its downstream end. This continuous flow of cooling air maintains the tray, and therefore the harnesses **44***a* and **44***b* (together with any other pipes and harnesses), at a lower temperature than the general temperature within Zone 3.

FIG. **3** shows a cross-sectional view on the line III-III of FIG. **2**. The tray **42** has a base **72** and side walls **74**, which are of the order of 125 mm high. The side walls **74** of the tray extend to within about 10-20 mm of a first fixed structure **76**. In this embodiment of the invention, the first fixed structure **76** is an annular core casing extending around the core of the gas turbine engine and forming the inner annular wall of the bypass duct **22**. The tray **42** is mounted to a second fixed structure **78**. In this embodiment the second fixed structure **78** is an annular casing located radially inward of the core casing **76** and surrounding the combustion equipment (**15** in FIG. **1**) of the gas turbine engine. Between the core casing **76** and the casing **78** is an annular space **82**, which lies within Zone 3 and through which flows the ventilation air flow **60**.

Harnesses **44***a* and **44***b* are mounted to the base **72** of the tray **42**. Suitable brackets ensure that the harnesses **44***a* and **44***b* are spaced from the base of the tray so that they are principally in contact with the flow of cooling air **70** rather than with a hot metal surface **72**.

Cool air **92** sourced from the bypass duct **22** flows through the cooling air duct **62** to provide the cooling air flow **64**. As mentioned previously, the end region **94** of the cooling air duct **62** is provided with holes or slots to disperse the cooling air flow **64** in a number of directions.

Because of the close proximity of the side walls **74** to the core casing **76**, the proximal surface, or inner wall, **80** of the core casing **76** effectively forms a fourth wall to the channel **84** defined by the base **72** and side walls **74** of the tray **42**, so that the air flow within the tray **42** is largely contained within it. The air flow **70** (FIG. **2**) therefore flows along the tray **42** with little, if any, leakage of air between the channel **84** and the annular space **82**. The cooling air **64** therefore provides effective cooling of the cable harnesses **44***a*, **44***b* (and of any other pipes or harnesses in the tray **42**). The static pressure within the tray **42** is very similar to the static pressure in the space **82**, which also helps to minimise leakage.

Although the side walls **74** are close to the inner wall **80** of the nacelle, it is desirable for the two to be separated by a small gap, to avoid damage in case of any relative movement between the two in operation. Because the annular casing **78** and the core casing **76** are separate components mounted to different structures of the gas turbine engine, it would introduce significant mechanical difficulties if the tray **42** were in contact with both.

Referring back to FIG. **2**, the mounting arrangement according to the invention therefore provides an effective cooling air flow **70** within the tray **42**, so that the temperature T_3 at the downstream end of the tray is significantly lower than the temperature T_2 at the same axial position outside the tray. The disconnect **54** can therefore be located further downstream, near to the downstream end of the tray **42**, maximising the use of the mechanically-robust PTFE-insulated cable **50** and minimising the requirement for the mechanically-fragile MI cable **52**.

In order to minimise the transfer of heat into the tray **42**, the base **72** and side walls **74** should have no holes, or as few holes as possible. This ensures that the tray will provide the maximum thermal protection against radiation from the surrounding, hot components and will also minimise leakage of hot air from the annular space **82** into the tray.

Various modifications will be apparent to those skilled in the art.

The holes or slots in the end region **94** of the cooling air duct **62** may take any suitable form; for example, they may be circular holes or elongated slots, or another arrangement such as 'pepper-pot' perforations. The distribution of the holes or slots may be varied to direct the cooling air flow **64** as required by a particular application. Thus, the holes may direct the air substantially uniformly in all directions, or they may direct the air preferentially in one or more directions. It is possible that the end region of the cooling air duct **62**, or the holes or slots, may be arranged to direct the cooling air flow **64** rearwards or downstream (i.e. in the same direction as the ventilation air flow **60**), but this may result in less mixing of the cooling air flow with the ventilation air flow; in general it would be desirable to mix the air flows more thoroughly so that the whole channel **84** within the tray is flooded by cooling air.

In the described embodiment, two cooling air ducts **62** are shown. In other embodiments, a different number of cooling air ducts may be employed. In some circumstances, for example, more cooling air flow may be required to provide sufficient cooling for the channel **84**; and this may be achieved by using more or larger cooling air ducts **62**. In order to avoid leakage of hot air from the annular space **82** into the channel **84**, it may be desirable to arrange for the pressure within the channel to be slightly higher than the pressure in the annular space so that there will be a small leakage flow out of the channel. If the pressure within the channel is higher than the pressure in the annular space, this will oppose or even prevent the ingress of ventilation air flow **60** through the opening **66** at the upstream end of the channel.

In other circumstances, less cooling air flow may be required, and this may be achieved by using smaller cooling air ducts or by using only one. In some applications, it may even be possible to dispense with the cooling air ducts altogether. In this case, the ventilation air flow **60** entering the channel **84** through the opening **66** would constitute the source of cooling air, and this air flow would provide sufficient cooling for the channel **84**.

In some embodiments, it may be desirable to limit the fraction of the ventilation air flow **60** that enters the channel **84**. This may be achieved, for example, by tapering the tray **42** so that it is narrower at its upstream end than at its downstream end; or by partially blocking the end of the tray **42** so that the opening **66** does not extend across the whole width of the tray. The opening **66** may then comprise either a single opening or a number of discrete openings.

It may be desirable, in some circumstances, to completely block the upstream end of the tray **42** so that no ventilation air flow **60** can enter the channel **84**. In this case, the whole of the cooling air flow **70** through the channel would be provided by the cooling air flows **64** supplied through the cooling air ducts **62**.

In a particular preferred embodiment of the invention, a gas turbine engine has two mounting arrangements in accordance with the invention, located on opposite lateral sides of the engine core. One arrangement carries the cable harnesses transmitting the 'channel A' signals and the other carries the cable harnesses transmitting the 'channel B' signals.

The invention claimed is:

1. A mounting arrangement for an electrical harness, wherein the arrangement is part of a gas turbine engine having an axial direction and a radial direction, the arrangement comprising:

an elongate tray internally mounted adjacent but not in contact with a first casing of the engine and outward of a second casing of the engine, the tray having a base and raised sides to define a channel extending along the axial direction, the electrical harness mounted within the channel; and

a cooling air source outward of the first casing in the radial direction, the source configured to provide cooling air into the channel to cool the electrical harness,

wherein the electrical harness includes a first type of cable disposed within the tray and a second type of cable comprising a material different from the first type of cable, the second type of cable extending beyond the tray,

wherein a tubular cooling air duct extends from the first casing into the channel in the radial direction, wherein the cooling air duct has a plurality of spaced outlet holes configured to eject the cooling air provided by the cooling air source from the cooling air duct into the channel in the radial direction and in the axial direction, and

wherein the first type of cable extends from a first region and the second type of cable extends into a second region, the first region being a cooler region than the second region.

2. The arrangement of claim **1**, wherein a proximal surface of the first casing forms a fourth wall for the channel.

3. The arrangement of claim **1**, wherein the cooling air duct passes through the first casing.

4. The arrangement of claim **3**, wherein the base of the tray is secured to the second casing.

5. The arrangement of claim **4**, wherein the first casing is formed by a nacelle or a thrust reverser of the engine and the second casing is a core casing of the engine.

6. The arrangement of claim **5**, wherein the cooling air source is within the nacelle or the thrust reverser.

7. The arrangement of claim **5**, wherein the cooling air source is a bypass duct of the engine.

8. The arrangement of claim **5**, wherein the tray extends along the axial direction.

9. The arrangement of claim **8**, wherein the cooling air duct is one of a plurality of cooling air ducts spaced in the axial direction.

10. The arrangement of claim **9**, wherein there is an annular space between the first casing and the second casing, and an upstream end of the tray has an opening configured to receive a portion of a ventilation flow from the annular space.

11. The arrangement of claim **1**, wherein the tray is narrower at an upstream end of the tray than at a downstream end of the tray.

12. The arrangement of claim **1**, wherein the first type of cable is polytetrafluoroethylene-insulated cable and the second type of cable is mineral-insulated cable.

13. The arrangement of claim **1**, wherein the plurality of spaced outlet holes are provided at an end region of the cooling air duct.

14. A gas turbine engine including the arrangement of claim **1**.

* * * * *